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SETS OF RELAYS FOR TWIN-CONDUCTOR CAPACITOR-TYPE CONNECTING LINES FOR THE ATS-47

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The article examines the circuits and the installation of sets of relays for twin-conductor capacitor-type connecting lines for the ATS-47; the principle of operation of these sets is based on a new Russian ring-off method. A device is described which automatically eliminates the failure to ring-off in 2-conductor connecting lines equipped with the above relay sets.

General Information

To make effective use of the capacity of existing interstation cables of municipal telephone networks and to reduce the cost of newly-installed cables, the TsNIIS /Tsentral'niy Nauchno-issledovatel'skiy Institut Svyazi -- Central Scientific Research Institute for Communication/ has simultaneously developed 2 variants of relay sets for twin-conductor interstation connecting lines: the neon-lamp connecting line relay, which subsequently was modernized into a thyratron connecting-line relay (RSL-T), and a variant of a connecting line relay of the capacitor type (RSL-K). The development of connecting line relay sets with gas-filled tubes /see Note below/ has resulted principally in the possibility of insuring a rather high input resistance of the ring-off relay connected in series with the tube in the speech wires. This was the principal advantage of a connecting-line relay of this type, for its development eliminated the need of investigating the distortion of the dialing pulses when twin conductor connecting lines are used.

(/Note:/ RSL-T sets are described in Vestnik Svyazi, No 1, 1952.)

It turned out later, however, that the use of a semifinished article such as a thyratron, which is nonstandard for the ATS /avtomaticheskaya telefonnaya stantsiya -- automatic telephone station/, not only fails to improve the circuit, but also leads to certain serious shortcomings. The principal shortcomings are: (1) increased value of the employed alternating current voltage (160 v); (2) need of installing a 25-cycle AC generator in the ATS and of installing step-up transformers as well as signal racks, equipped with panels containing switching and signal relays, voltmeters with signal contacts, and other instruments; (3) use of the loop method of transmitting the AC ring-off signal; this method unavoidably causes spinning of the brushes of the selectors of the various steps and an excessive wear of the mechanism whenever the subscriber fails to make connection during the time that the number is dialed, and also during the process of eliminating the failure to ring-off in the called sets of connecting line relays; (4) the need for storing at each ATS a considerable number of spare thyratrons which are relatively expensive; (5) need for providing each ATS with special instruments for testing the thyratrons.

In the development of the RSL-K sets, the principle of operation of which is based on a new Russian ring-off method /see Note below/, the aim was to use in these sets only those elements that are quite stable and that do not differ at all from those ordinarily used in the ATS circuits. Such twin-conductor connecting-line relays, being of the same type as the equipment of any ATS, could easily be produced by the

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industry. It would also be desirable to avoid employing supplementary sources of alternating-current and step-up transformers.

(/Note:/ Inventor's certificate No 90,533, class 21 a^3, 34/20, priority of 6 April 1950.)

The following basic technical requirements were imposed on the developed twin-conductor connecting-line relays: (1) reliable operation over connecting lines, in which the resistance of each wire does not exceed 1,500 ohms on the section from the IGI /First Group Selector/ to the LI /Line Selector/; (2) the connecting-line relay sets must not impair the quality of the telephone communication and must not introduce changes in the circuits of the basic ATS instruments; (3) 2 sections of twin-conductor connecting lines should be capable of being connected in one speech path; (4) the use of the connecting-line relays should not cause excessive wear on the selectors owing to spinning of their brushes at the instant when a ring-off pulse passes through the connecting line.

The circuits developed for the calling and called sets RSL-K for the ATS-47 fully satisfy the above requirements. These sets insure reliable action over the connecting line, in which each wire has a resistance exceeding 2,000 ohms, using the existing station common 25-cycle source of ringing current to transmit the ring-off pulses. Prolonged experimental operation of commercial sets RSL-T and RSL-K has shown that at present the RSL-K sets are the most acceptable. The industry has already started output of new, larger experimental series of these sets.

The features of the twin-conductor RSL-K circuits, their basic shortcomings, and methods of eliminating these shortcomings will be discussed below, after we shall describe the principal RSL-K circuits which were perfected during the experimental operation.

Current Flow in the RSL-K Circuits

The RSL-K circuits are installed in regionalized municipal telephone networks, equipped with decade-stepped ATS. Each twin-conductor connecting line is connected on one end to the output of the calling set of connecting-line relays (out RSL) and the other end to the input of the called set (in RSL), as shown in Figure 1. These sets are intended for connecting the twin-conductor connection lines from the decade-stepped ATS to the decade-stepped ones (Figures 1a and b), from decade-stepped ATS to machine ones through intermediate equipment (Figure 1c), and from machine ATS to decade-stepped ones with the countering set (VK) being directly connected to the calling connecting-line relay set (Figure 1d).

The principal diagram of the RSL-K sets is shown in Figure 2. It contains 5 type-RPN relays, of which 3 belong to the calling and 2 to the called sets. The circuit is based on the principle of engaging and releasing the sets of the called station whenever short-period pulses, transmitted by the calling connecting-line relay sets are received, and provides for continuous supervision of the working order of the connecting lines, of the presence and working order of the called connecting-line relay sets and of the II/IV GI /II/IV Group Selector/ (or other sets) connected with it. For this purpose a control relay K (7,300 ohms) is provided in the calling set, and this relay operates in the loop of the connecting line, receiving the plus feed from contact 2-1 of push-button Bl. Kn. of the called connecting-line relay set over wire a, and receiving the minus feed from relay O in the II/IV GI circuit over

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wire c and further through the winding of relay Z (350 ohms and 1,000 ohms) over wire b. In this circuit, the relay Z of the called connecting-line relay set and relay O in the II/IV GI circuit do not operate, for they do not receive enough current.

If the control circuit is in working order relay K pulls in its armature and contacts k^{I} (1-2) and k^{V} (1-2) prepare the circuit of the calling connecting-line relay set for engagement by the selector of the preceding selection step (over wire c) and by mixing selector SI (over wire b). In addition, contact k^{III} (2-3) of this relay opens the circuit to the signal lamp SL and contact k^{V} (3-4) of this relay disconnects the connecting-line relay set from the discard circuit.

When the brushes of the IGI (or of the II/IV GI) stop on the outlets to the free calling set, the test relay P will operate in the circuit of this group selector, receiving a minus feed over the c wire through relay O (350 ohm) of the calling set. Relay O in this circuit operates and seals in with contact o^{I} (1-2) until relay R operates. Contact o^{III} (4-5) of the O relay connects the high-speed relay R, and contacts o^{V} (2-3) and o^{I} (1-3) break the control circuit and connect wire b, while contacts o^{V} (1-2) and o^{III} (3-4) prepare the circuit that registers the load and breaks the discard circuit. Relay K releases its armature with a time delay of 50 to 60 milliseconds, owing to the transition contact o^{V} (1-3), which shunts the winding of this relay. During this time the engagement pulse will arrive from the calling-set circuit, and this pulse will actuate the engagement relay Z in the incoming set, receiving the plus feed over wire b of the connecting line from the contact k^{III} (2-3) and the minus feed over wire c from the II/IV GI circuit.

Mounted on relay Z are the transfer-switching contact groups No 95 (z^{I} and z^{V}); therefore a triple contact is formed in them prior to the opening, and relay Z received additional supply over a local circuit andis sealed-in in this circuit by contact z^{V} (1-3). Contacts Z^{I} (1-3) and z^{III} (4-5) connect the conversation wires a and b, while contact z^{III} (1-2) closes the circuit for "added supply" of the winding of relay O, which is connected by contact z^{V} (1-3) through resistor r2.

In the outgoing set, relay R pulls in its armature after relay O operates. The contacts r^{V} (4-3) and r^{V} (4-5) of this relay remove the shunt from the second winding of relay O and connect this winding to wire c; as a result the holding circuit of relay O remains on after contact k^{I} (1-2) opens, and the set seals-in until the ring-off pulse is transmitted. Contacts r^{I} (1-2) and r^{III} (3-2) prepare the circuit by which this pulse is transmitted with alternating current and eliminate the possibility of the control circuit becoming closed after the armature of relay O drops out in the calling RSL set. Contacts r^{V} (3-4) and r^{I} (4-5) break the circuit that tests for engagement of mixing selector SI over wire d and close the circuit to counter Sch which records the number of engagements. Thus, once the called set becomes engaged, relay Z remains energised in it, while relays O and R remain energized in the calling set. Connected in parallel to the speech wires of the receiving set is a differential bridge (consisting of 2 0.5 microfarad capacitors, the 2 pairs of symmetric windings of relay Z, and choke L), and the ring-off relay O is connected to the center point of this bridge.

The process of further dialing the number and establishing the connection is carried out in the usual manner. After ring-off, the circuit over which relay O of the calling set receives its supply from the side of the group-selector of the preceding step becomes open. Relay O releases its armature and relay R becomes deenergized. During the time that relay R drops out (80-110 milliseconds) the ring-off pulse is transmitted with alternating current over both principal circuits through the connecting line from the called station side. In the calling set, each of these circuits begins with the terminals of the secondary half-winding of the general station transformer Tr, to which is connected the 60-v central battery, and passes through a set of individual fuses for each wire, a protective lamp (L_a, L_b), a limiting resistance (r_1 and r_2) and the suitable contacts of relays O and R. In the called set these circuits comprise the contact springs of the test jack (I. Gn.), the corresponding arms of the differential bridge, and the winding of ring-off relay O (2,000 ohms).

The passage of alternating current through the above-mentioned circuits causes operation of relay O, which, first of all, for a short time prior to the release of the armature of relay Z, is blocked by its contact o^{II} (1-2) in the local circuit (through resistance r_3), and whose contact o^{IV} (1-2) later breaks the holding circuit for relay Z of the called set and of relay O in the II/IV GI circuit. The latter relay releases its armature, after which the II/IV GI "goes off" into ring-off.

Releasing the armature of relay Z shunts relay O and disconnects its "added supply" and prepares for the formation of the control circuit. This method of disconnecting the ring-off relay O insures that the time heeded to release its armature ranges from 350 to 380 milliseconds. Thanks to this, the called set cannot be occupied during the time that the alternating current ring-off signal passes through, even if up to 4 sections of twin-conductor connecting lines participate in the connection.

After relay R of the calling set and relay O of the receiving set release their armatures, and the brushes of the II/IV GI return to the initial position, the control circuit is again formed. Relay K of this circuit operates; the circuits of the set reach the nonworking state, and the connecting line is prepared for the next occupancy.

If the control circuit becomes damaged for some reason or other, the relay K of the calling set releases its armature, and this closes the circuit for the technical signalization. The signal relay TS (which is located on the signal panel of the RSL rack) of this circuit operates, receiving its plus supply from contact k^{III} (1-2) through the contact of relay O, pushbutton Bl. Kn., and signal lamp SL (one per panel). At the same time a circuit is produced, through which relay R receives the discard pulses over wire SU through contacts k^V (3-4) and o^{III} (3-4), and through the pushbutton used to disconnect the discard equipment (Kn. SU).

Within approximately one to 4 seconds a plus signal lasting for 25 to 30 seconds is transmitted from the discard equipment SU, and this results in the operation of disconnect relay R, and contacts r^I (1-2) and r^{III} (2-3) transmit into the connecting line an alternating-current disconnect pulse. Such pulses can arrive from the discard equipment SU every 5 seconds. If the control circuit does not become restored under the influence of the discard equipment within one minute (i.e., if the state of the so-called failure to ring-off is maintained), testifying to a damage to the connecting line or to the sets on the called ATS, the rack and row signalization will go into effect. To determine on which panel a RSL set with a faulty connecting line is located, the technician on watch should press the common pushbutton TS, which causes the signal lamp SL to glow.

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windings, eliminates completely the first of the above-mentioned shortcomings, namely, the possibility of spinning the selector brushes of the next stage during ring-off if the dialing has not been completed and duringthe elimination of the failure to ring-off with the aid of the discarding device. During the experimental operation of the RSL-K, the station transformer for the ringing current was used as a source of alternating current. The winding of the above transformer has, as is well known, a "minus" polarity; therefore, during ring-off the pulse relay I in the II/IV GI circuit has operated sometimes because of current passing through one of the windings (with plus polarity), which receives a minus supply through the transformer winding. (It must be noted that if the loop method is used to transmit the ring-off signal with alternating current at 25 or 50 cycles it is impossible to eliminate completely cases of selector brush spinning inasmuch as the alternating current passes in series through the windings of the pulse relay I.) In order to eliminate the second of the above shortcomings, the relay O in the circuit of the calling set is blocked until relay R operates. In addition, relay R, which formerly had a time-delay winding on its core, is now equipped with a controllable time-delay winding and has thus become faster in action.

The discard device that has been developed, which is of the pulse type, and in which the plus signal is at different times to 6 groups of RSL panels, does not allow the discard pulses to enter into sets that are in working order, inasmuch as the connecting circuit of this device is formed in these sets only for the time during which the selector brushes return to the initial position, plus the duration of the time required for relay K to operate (i.e., within 300 to 400 milliseconds). However, for RSL sets that are not in working order, the relays K and O do not pull in their armatures, and therefore, prior to the arrival of the plus signal from the 5-second interrupter (i.e., for the duration of one second), the only control relays that remain blocked in the discard device are those on panels with RSL that are not in working order. The use of such a discard device insures automatic elimination of failure to ring-off prior to the appearance of a technical signal, and therefore the technical personnel is called upon to intervene only in those cases in which the connecting line or the corresponding instruments are damaged.

Economic Effect of Introducing the Twin-Conductor Connecting-Line Relays

The general shortcoming of twin-conductor connecting-line relays of any type is the need of installing supplementary equipment at the automatic telephone station and this requires a certain amount of installation space. This naturally increases somewhat the capital expenditures and the operating costs, and also the consumption of nonferrous metals for station equipment. However, technical-economic analysis has shown that these additional costs caused by the introduction of twin-conductor connecting-line relays are offset by the more considerable reduction in capacital expenditures and operating costs for line structures and by a substantial reduction in consumption of nonferrous metals in these structures. (This is based on preliminary data of the TsNIIS which can be refined only after the connecting-line relays become available in regular production.)

Therefore, the introduction of 2-conductor connecting-line relays becomes economically advantageous with respect to the various indexes under certain conditions:

(1) With respect to capital expenditures -- if the connecting line is 3.5 km long; here the consumption of nonferrous metal for station structures increases by 0.5 t, and the consumption for line structures

decreases by 10.8 t if 800 calling and called twin-conductor connecting-line relay sets are installed each in a 10,000-line automatic telephone station; at the same time the annual expenditures for maintenance of the connecting line decreases by 2.5 times.

(2) With respect to copper consumption — if the connecting line is 200 m long.

(3) With respect to operating expenses — if the connecting line is 1.3 km long.

Considering that the length of the interstation connecting lines exceeds 3.5 km in the majority of large nets and that the number of regionalized nets increased every year, it is easy to visualize the tremendous economic effect that will result from introducing twin-conductor connecting-line relays in all regionalized nets.

FIGURES

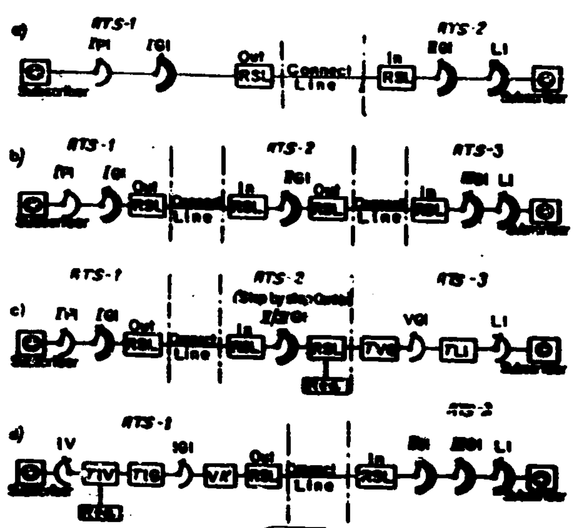

Figure 1

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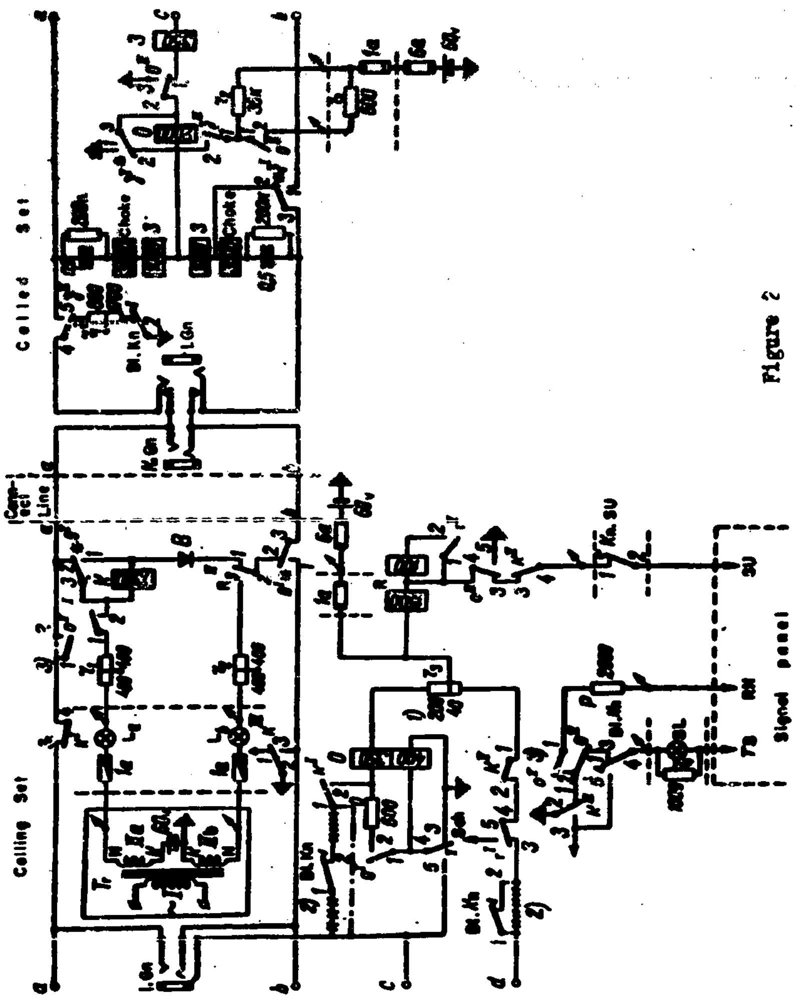

Figure 2

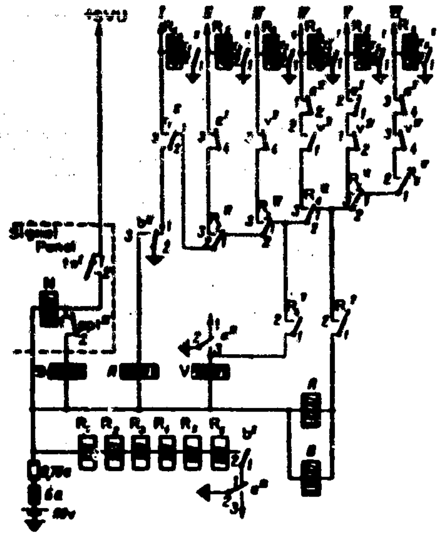

Figure 3

Figure 4

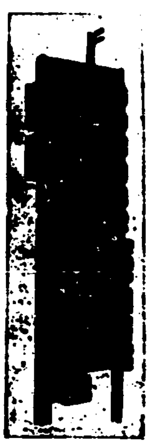

Figure 5

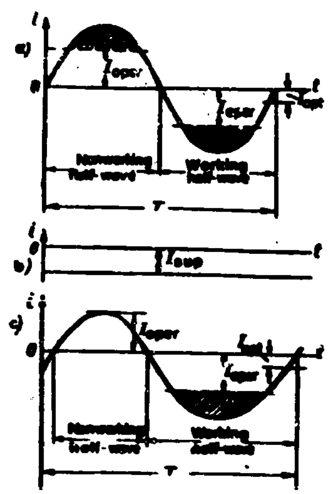

Figure 6

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